Rec'd PCT/PTO 10 MAR 2005

10/527198

PATENT COOPERATION TREATY

From the
INTERNATIONAL PRELIMINARY EXAMINING AUTHORITY

PCT

To:

REINHOLD COHN AND PARTNERS
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ISRAEL

RECEIVED
24-01-2005
REINHOLD COHN AND PARTNERS

NOTIFICATION OF TRANSMITTAL OF THE INTERNATIONAL PRELIMINARY EXAMINATION REPORT

(PCT Rule 71.1)

Date of mailing (*day/month/year*)	19.01.2005

Applicant's or agent's file reference	
147522.7 IL	**IMPORTANT NOTIFICATION**

International application No.	International filing date (*day/month/year*)	Priority date (*day/month/year*)
PCT/IL 03/00727	04.09.2003	12.09.2002

Applicant
A.R.I. FLOW CONTROL ACCESSORIES... et al.

1. The applicant is hereby notified that this International Preliminary Examining Authority transmits herewith the international preliminary examination report and its annexes, if any, established on the international application.

2. A copy of the report and its annexes, if any, is being transmitted to the International Bureau for communication to all the elected Offices.

3. Where required by any of the elected Offices, the International Bureau will prepare an English translation of the report (but not of any annexes) and will transmit such translation to those Offices.

4. **REMINDER**

The applicant must enter the national phase before each elected Office by performing certain acts (filing translations and paying national fees) within 30 months from the priority date (or later in some Offices) (Article 39(1)) (see also the reminder sent by the International Bureau with Form PCT/IB/301).

Where a translation of the international application must be furnished to an elected Office, that translation must contain a translation of any annexes to the international preliminary examination report. It is the applicant's responsibility to prepare and furnish such translation directly to each elected Office concerned.

For further details on the applicable time limits and requirements of the elected Offices, see Volume II of the PCT Applicant's Guide.

The applicant's attention is drawn to Article 33(5), which provides that the criteria of novelty, inventive step and industrial applicability described in Article 33(2) to (4) merely serve the purposes of international preliminary examination and that "any Contracting State may apply additional or different criteria for the purposes of deciding whether, in that State, the claimed inventions is patentable or not" (see also Article 27(5)). Such additional criteria may relate, for example, to exemptions from patentability, requirements for enabling disclosure, clarity and support for the claims.

Name and mailing address of the international preliminary examining authority:	Authorized Officer
European Patent Office D-80298 Munich Tel. +49 89 2399 - 0 Tx: 523656 epmu d Fax: +49 89 2399 - 4465	Vilz, B Tel. +49 89 2399-2292

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PATENT COOPERATION TREATY

PCT

REPLACED BY ART 34 AMDT

INTERNATIONAL PRELIMINARY EXAMINATION REPORT

(PCT Article 36 and Rule 70)

Applicant's or agent's file reference 147522.7 IL	**FOR FURTHER ACTION** See Notification of Transmittal of International Preliminary Examination Report (Form PCT/IPEA/416)	
International application No. PCT/IL 03/00727	International filing date *(day/month/year)* 04.09.2003	Priority date *(day/month/year)* 12.09.2002
International Patent Classification (IPC) or both national classification and IPC G01F15/00		
Applicant A.R.I. FLOW CONTROL ACCESSORIES.:. et al.		

1. This international preliminary examination report has been prepared by this International Preliminary Examining Authority and is transmitted to the applicant according to Article 36.

2. This REPORT consists of a total of 9 sheets, including this cover sheet.

☒ This report is also accompanied by ANNEXES, i.e. sheets of the description, claims and/or drawings which have been amended and are the basis for this report and/or sheets containing rectifications made before this Authority (see Rule 70.16 and Section 607 of the Administrative Instructions under the PCT).

These annexes consist of a total of 22 sheets.

3. This report contains indications relating to the following items:

- I ☒ Basis of the opinion
- II ☐ Priority
- III ☐ Non-establishment of opinion with regard to novelty, inventive step and industrial applicability
- IV ☒ Lack of unity of invention
- V ☒ Reasoned statement under Rule 66.2(a)(ii) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement
- VI ☐ Certain documents cited
- VII ☐ Certain defects in the international application
- VIII ☐ Certain observations on the international application

Date of submission of the demand 22.03.2004	Date of completion of this report 19.01.2005
Name and mailing address of the international preliminary examining authority: European Patent Office D-80298 Munich Tel. +49 89 2399 - 0 Tx: 523656 epmu d Fax: +49 89 2399 - 4465	Authorized Officer Papantoniou, E Telephone No. +49 89 2399-2468

INTERNATIONAL PRELIMINARY EXAMINATION REPORT

International application No. PCT/IL 03/00727

I. Basis of the report

1. With regard to the **elements** of the international application *(Replacement sheets which have been furnished to the receiving Office in response to an invitation under Article 14 are referred to in this report as "originally filed" and are not annexed to this report since they do not contain amendments (Rules 70.16 and 70.17))*:

Description, Pages

1-16 received on 20.12.2004 with letter of 20.12.2004

Claims, Numbers

1-41 received on 20.12.2004 with letter of 20.12.2004

Drawings, Sheets

1/8-8/8 as originally filed

2. With regard to the **language**, all the elements marked above were available or furnished to this Authority in the language in which the international application was filed, unless otherwise indicated under this item.

These elements were available or furnished to this Authority in the following language: , which is:

- ☐ the language of a translation furnished for the purposes of the international search (under Rule 23.1(b)).
- ☐ the language of publication of the international application (under Rule 48.3(b)).
- ☐ the language of a translation furnished for the purposes of international preliminary examination (under Rule 55.2 and/or 55.3).

3. With regard to any **nucleotide and/or amino acid sequence** disclosed in the international application, the international preliminary examination was carried out on the basis of the sequence listing:

- ☐ contained in the international application in written form.
- ☐ filed together with the international application in computer readable form.
- ☐ furnished subsequently to this Authority in written form.
- ☐ furnished subsequently to this Authority in computer readable form.
- ☐ The statement that the subsequently furnished written sequence listing does not go beyond the disclosure in the international application as filed has been furnished.
- ☐ The statement that the information recorded in computer readable form is identical to the written sequence listing has been furnished.

4. The amendments have resulted in the cancellation of:

- ☐ the description, pages:
- ☐ the claims, Nos.:
- ☐ the drawings, sheets:

5. ☒ This report has been established as if (some of) the amendments had not been made, since they have been considered to go beyond the disclosure as filed (Rule 70.2(c)).

   (Any replacement sheet containing such amendments must be referred to under item 1 and annexed to this report.)

   see separate sheet

6. Additional observations, if necessary:

IV. Lack of unity of invention

1. In response to the invitation to restrict or pay additional fees, the applicant has:

   ☐ restricted the claims.

   ☐ paid additional fees.

   ☐ paid additional fees under protest.

   ☐ neither restricted nor paid additional fees.

2. ☒ This Authority found that the requirement of unity of invention is not complied with and chose, according to Rule 68.1, not to invite the applicant to restrict or pay additional fees.

3. This Authority considers that the requirement of unity of invention in accordance with Rules 13.1, 13.2 and 13.3 is

   ☐ complied with.

   ☒ not complied with for the following reasons:

   see separate sheet

4. Consequently, the following parts of the international application were the subject of international preliminary examination in establishing this report:

   ☒ all parts.

   ☐ the parts relating to claims Nos. .

V. Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

1. Statement

Novelty (N)	Yes:	Claims	5, 7, 13, 15, 22, 23, 25, 30 - 41
	No:	Claims	1 - 4, 6, 8, 9 -12, 14, 16 - 21, 24, 26 - 29
Inventive step (IS)	Yes:	Claims	
	No:	Claims	1 - 41
Industrial applicability (IA)	Yes:	Claims	1 - 41
	No:	Claims	

2. Citations and explanations

see separate sheet

Re Item I
Basis of the report

The amendments filed with the letter dated 20.12.04 introduce subject-matter which extends beyond the content of the application as filed, contrary to Article 34(2)(b) PCT. The amendments concerned are the following:

In claims 1, 12, 28, 41, the wording "the valve is adapted .... to **periodically** prohibit fluid flow" (line 9 of page 17) and in claims 1, 12 the wording "the flow meter is adapted to **simultaneously** measure the admitted fluid flow" (line 14 of page 17).

As far as understood, the originally filed documents only disclose that the valve (36, 50, 80, 100, 150) is either at an open position, when the flow is above a threshold value, or at a pulsating position at low flow-rates. Although at the pulsating position, no flow occurs except when the pressure builds-up so much as to allow a pulse of fluid to exit the valve, no support could be found that such pulse is "periodic".
In addition, the originally filed documents only disclose that at low flow-rates, the valve (36, 50, 80, 100, 150) remains closed until the pressure differential over the valve ports reaches a given value, then the valve opens and a pulse of fluid enters the outlet port (56). From the outlet port, the fluid travels to the flowmeter, which provides for a delay, depending on the distance between the valve and the flowmeter. No support could be found that such pulse of fluid is measured "simultaneously" by the flow meter (12).

The present report is written, without taking in account these two definitions.

Re Item IV
Lack of unity of invention

Independant claims 1, 12, 16, 28 and 41 are not linked by common, or corresponding special technical features and define different inventions not linked by a single general inventive concept. The application, hence does not meet the requirements of unity of invention as defined in Rules 13.1 and 13.2 PCT.

In particular, the only common feature of claims 1, 12, 16, 28, 41 is the flow responsive valve/method, which is defined as including an inlet and an outlet port. No inventive

concept, or special feature can be found in such trivial definition of a valve, so that a valve having inlet/outlet ports, can not be considered as a special technical feature within the meaning of Rule 13.2 PCT.
It is also noted that in addition to the definition of a valve having an inlet/outlet port, as defined above, claims 1 - 15, 28 - 41, also include the common feature that the valve is shifting from an open to a pulsating position, depending on the flow rate. Such feature is known from **D1 = WO-A-99 28722**. See in particular the embodiment of Fig. 7, D1, with the valve (8, Fig. 7, D1), which pulsates at low flow rates (see page 7, lines 7 - 22, D1).

Since independant claims 1, 12, 16, 28 are not new in view of D1 (see part V bellow), this Authority considers that there are 4 inventions covered by the claims indicated as follows:

I: The system and method of Claims 1 - 15.
II: Claims 16 - 27.
III: Claims 28 - 40.
IV: Claim 41.

Re Item V
Reasoned statement with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

1. Reference is made to the following document:
   D1: **WO-A-99 28722**

2. Claim 1
   D1 shows in Fig. 5, D1, a fluid metering system comprising:
   - A fluid supply line (25, Fig. 5, D1).
   - A flow meter (17, Fig. 5, D1) for measuring the fluid flow. Any fluid flow meter has a minimum measuring threshold.
   - A valve (8, Fig. 5, D1).
   The valve (8, Fig. 5 and 7, D1) of D1, is shown in different embodiments, and as shows in Fig. 7, D1, the valve (8) includes an inlet (15, Fig. 7, D1) and an outlet port (20, Fig. 7, D1) and is shiftable between an open position (at high flow rates, when the pressure keeps the valve body (3) away from the valve seat (9), Fig. 7, D1) and a

pulsating position, in which the valve is adapted to prohibit fluid flow until a pressure difference over the valve ports is being build-up (see pulsator 19, Fig. 7 and page 7, lines 7 - 22, D1).
It is noted that D1 makes explicit mention of the valve positions. E.g. it defined "in case of minimal flows, ... the valve is closed" (see page 7, lines 7, 8, D1), and the pulsator forces the valve to alternately open and close, e.g. pulsate (see page 7, lines 19, 20, D1).
In addition, D1 also measures the flow, even if this flow is very small. See e.g. the first paragraph of page 1, defining the invention as "measuring ... a flow, especially leaks". See also the reference in page 6, line 20, 21, D1, that the valve forms "a simple flow sensor", and thus clearly measures the flow, even when the flow is small. Although, D1 uses an extra shunt pipe for the leak-flow, such arrangement is also able to measure the flow rate, as mentioned in the these two passages of D1.

Thus the subject matter of claim 1 is not new (Article 33(2) PCT).

3. The method steps of claim 12 correspond to the features of claim 1. Thus the subject matter of claim 12 is not new (Article 33(2) PCT) for equivalent reasons, as mentioned in part 2, above (Article 33(2) PCT).

4. Claim 16
D1 shows in Fig. 7, D1, a valve (8, Fig. 5, D1) comprising an inlet port (15, Fig. 7, D1) and an outlet port (20, Fig. 7, D1) connectable respectively to an downstream and upstream side of a fluid supply line (25, Fig. 5, D1). Said valve having a housing (8, Fig. 8, D1) defining a control chamber extending between the inlet and outlet ports (15, 20, Fig. 7, D1) and a sealing member (3, Fig. 7, D1), the dimensions of the valve seat and valve body (9, 3, Fig. 7, D1) define a bleed aperture determining a minimal flow threshold through the control chamber. The sealing member (3, Fig. 7, D1) is displaceable between an open and a closed position depending on the pressure difference over the sealing member (3, Fig. 7, D1).

Thus the subject matter of claim 16 is not new (Article 33(2) PCT).

5. Claim 28
D1 shows in Fig. 7, D1, a flow responsive valve (8, Fig. 5, D1) for a flow metering

system. The metering system comprising a supply line (25, Fig. 5, D1), a flow meter (17, Fig. 5, D1), which by definition has a minimum measuring threshold. The valve (8, Fig. 5, D1) having an inlet port (15, Fig. 7, D1) and an outlet port (20, Fig. 7, D1). The valve is shiftable between an open and a pulsating position (see Fig. 6b, D1, showing the open position and page 7, lines 7 - 22, D1, explaining the pulsating position).

Thus the subject matter of claim 28 is not new (Article 33(2) PCT).

6. Claim 41
D1 shows in Fig. 5, D1, a fluid metering system comprising a fluid supply line (25, Fig. 5, D1) and a flow meter (17, Fig. 5, D1) for measuring the fluid flow. Any fluid flow meter has a minimum measuring threshold. The system further comprises a flow responsive valve (8, Fig. 5, D1) having an inlet port (15, Fig. 7, D1) and an outlet port (20, Fig. 7, D1). The valve is shiftable between an open and a pulsating position (see Fig. 6b, D1, showing the open position and page 7, lines 7 - 22, D1, explaining the pulsating position). Furthermore, the valve (8, Fig. 7, D1) also includes a suspension mechanism (spring 7 and magnets 1, 2, Fig. 7, D1), such mechanism delays the initial fluid flow entering the valve.

Thus the only difference between the subject matter of claim 41 and D1, is that present claim 41 defines that the flow meter comprises "a fluid flow responsive impeller", while D1 does not give any details of what type of flow meter is used. Thus the object of the present application can be seen as providing particular details of the flowmeter used.

However, the use of rotary flowmeters (which include an impeller, the rotation of which is proportional to the fluid flow) for measuring the flow of a system, such as a residence, is the most obvious choice.

Thus the subject matter of claim 41 is not inventive (Article 33(3) PCT).

7. The features of dependant claims 5, 7, 13, 15, 22, 25, 30 - 40 seem to be new in view of D1, however, they seem to define obvious constructional alternatives to the valve of D1. Thus these claims are not inventive (Article 33(3) PCT). The rest of the

dependant claims disclose features which are already known from D1 and are thus not new (Article 33(2) PCT).

8/PRTS

VALVE FOR PREVENTION OF LOW FLOW RATES THROUGH FLOW METER

FIELD OF THE INVENTION

This invention relates to a method, a system and a device for metering fluid flow. More particularly the invention is concerned with a method rendering a conventional fluid meter suitable for metering also significantly low flow rates, even below the measurable flow rate of the metering device. The invention is further concerned with a fluid flow measuring system and a device useful for carrying out the method.

BACKGROUND OF THE INVENTION

The measurement and monitoring of low volume fluid flows has various applications including applications in industrial and residential settings. For example, in the chemical industry the accurate and precise knowledge of inlet and outlet flows for a myriad of processes (e.g. chemical reactions) can be critical to the optimal production and processing of chemicals, pharmaceuticals and the like. Precise monitoring of flows can also be used to discover and prevent leaks which can be costly and be a safety issue.

Additionally, the lack of low-flow monitoring can result in losses to the suppliers of such flow. For example, water companies are compensated for water usage as measured by their flow monitors (water meters). If their flow monitors do not measure trickle or drip flow, they are not reimbursed for such usage. The loss of revenue can be considerable. Additionally, the location of the loss is not detected thereby allowing a large amount of water to be wasted. This is particularly an issue in the many countries with limited water supplies. Furthermore the knowledge of

this monitoring limitation can be used to steal water, for example by slowly dripping water into a holding tank, at a rate not measurable by the associated flow meter, and consuming the water directly from the tank.

Turbine flow meters, which are the conventional magnetic flow meters in general use today have long been used to measure fluid flow by means of a turbine immersed in the fluid. A magnet connected to the turbine turns a second magnet, which is placed in a dry area. The second magnet drives a cog system that turns a mechanical counter. These flow meters are unable to detect low flows e.g. below about 10 l/h when considering a typical water meter of the type installed by water supply companies and municipalities world wide. Positive displacement metering devices are also commonly used to measure flow rate and they have deficiencies in particular where water is of poor quality i.e. has a high calcium content or contains dirt such as sand.

Other types of flow meters are also known, some of which are devices for measuring low volumetric fluid flow. However such meters are typically costly, require servicing and are difficult to retrofit, thus are usually not used for domestic water metering.

Droplet counter devices are also known, wherein a sensor is provided for droplet count. However, such devices usually serve for laboratories and are not cost-effective in massive installation, e.g. for use by a water supply company, certainly not for urban use. Even more so, such systems are not easily retrofitted and they require some considerable space.

For example, disclosed in U.S. Patent No. 5,218,346 to Meixler is a low volume flow meter for determining if a fluid flow meets a minimum threshold level of flow. The monitor includes an externally located electrical portion, which operates with a minimum of intrusion to the flow and allows for repairs. The electronics provide for the adjustment of the threshold level and can be modified to provide for a parallel electronic circuit for a bracketing of the desired flow rate. However, the system is not simple or inexpensive.

Another type of flow rate device that has the capacity to measure or monitor a low flow rate is a compound meter. In this case, the device comprises a high flow metering device together with a secondary flow meter that is typically located in a by-pass conduit. There is typically some means for diverting flow (e.g. by using a *"change-over"* valve set to activate at a pre-determined pressure) based on a pre-determined flow rate or pressure in order to direct the flow to the appropriate meter. These meters typically suffer from at least some of the above-mentioned drawbacks and in particular are expensive.

A problem which may occur with flow metering devices is so-called *'over-efficiency'*, where the flow meter may read excessive amounts of fluid, which in fact have not flown through the system. This may result for example, owing to inertial revolutions of the measuring impeller of the metering device.

SUMMARY OF THE INVENTION

According to the invention there is provided a fluid supply system comprising a supply line and flow metering device and a flow responsive valve; said pressure metering device admitting flow through the system for only measurable fluid flow.

The arrangement is such that when flow rate exceeds a minimal measurable flow rate threshold the valve is open owing to a pressure differential over its inlet port and outlet port; and when the flow rate drops below said minimal measurable flow rate threshold, the valve enters a pulsating position having a closed state thereby substantially restricting flow through the system, and an open state allowing fluid flow into the system; said open state having a flow rate exceeding the minimal measurable flow rate threshold; where portions of the supply line downstream of the flow meter and devices fitted thereon function as a fluid accumulator.

According to the invention, an average fluid flow through the system remains constant over time, whereby a consumer downstream of said metering

device does not acknowledge flow rate fluctuations imparted by the system according to the present invention.

According to the invention, there is a fluid metering system comprising a fluid supply line and a meter for measuring fluid flow therethrough, said meter having a minimum measuring flow threshold; the system further comprising a flow responsive valve imparting the system with a flow pattern having a pulsating character so as to substantially prohibit flow at a flow rate below the minimum measuring threshold, and resume flow of only measurable quantities of fluid. The flow responsive valve is in fact responsive to flow rate and to pressure differential extending between an inlet and an outlet of the valve.

According to another aspect the present invention is concerned with a method for metering fluid flow through a fluid supply line comprising a flow meter having a minimum measurable threshold and a flow responsive valve imparting a flow pattern therethrough with a pulsating character so as to substantially restrict flow at a flow rate below the minimum measuring threshold, and resume flow of only measurable quantities of fluid. The arrangement is such that the fluid supply line and any devices fitted thereon function as an accumulator, whereby at an open state of the flow responsive valve, during its open phase, fluid accumulates in the system.

The present invention is also directed to a valve comprising an inlet port connectable to an upstream side of a fluid supply line, and an outlet port connectable to an downstream side of the fluid supply line; a control chamber extending between the inlet port and the outlet port and a sealing member disposed within said control chamber; said sealing member having an inlet sealing surface having a sealing surface area and a control portion having a control surface area; and a bleed aperture determining a minimal flow threshold through the control chamber; wherein the sealing member displaces between an open position and a closed position depending on a pressure differential over the sealing member.

A fluid supply system according to the concerned invention is suitable for use with gases or liquids and has a significant advantage of being inexpensive, reliable and suitable for easy retrofit installation on existing flow metering systems.

A further advantage of the device in accordance with the present invention is that it serves also as a one way valve preventing flow from a downstream direction to an upstream direction, i.e. from the consumer towards the supplier, in the case of a liquid supply system.

According to another embodiment of the present invention there is provided a flow responsive valve according to the invention, further fitted for controlled restriction of fluid flow at the open state of the pulsating position of the device. Accordingly, an impeller of a flow meter fitted in conjunction with a valve according to this embodiment will not reach significant revolutionary speed and inertial force is reduced, thereby governing the overriding excessive metering. However, the valve according to this embodiment substantially does not effect fluid flow and metering at a consuming state thereof, i.e. when flow rate exceeds a minimal measurable flow rate threshold.

BRIEF DESCRIPTION OF THE DRAWINGS

In order to understand the invention and to see how it may be carried out in practice, some embodiments will now be described, by way of non-limiting examples only, with reference to the accompanying drawings, in which:

Fig. 1 is a schematic representation of a municipal water supply network fitted with a flow metering system according to the present invention;

Fig. 2 is a superimposed graph schematically illustrating the pressure and flow rate over time, in a water supply network fitted with a system according to the present invention;

Figs. 3A and **3B** are longitudinal sections through a flow responsive valve according to an embodiment of the present invention, wherein:

Fig. 3A illustrates the valve in its open position; and

Fig. 3B illustrates the valve in its closed position;

Figs. 4A and **4B** are longitudinal sections through a flow responsive valve according to another embodiment of the present invention, wherein:

Fig. 4A illustrates the valve in its open position; and

Fig. 4B illustrates the valve in its closed position;

Fig. 5 is a longitudinal section through a flow responsive valve according to still an embodiment of the present invention, wherein:

Fig. 5A illustrates the valve in its open position; and

Fig. 5B illustrates the valve in its closed position;

Fig. 6 is a schematic graph representing actual flow Vs. measured flow, at several conditions;

Fig. 7 is a longitudinal section through a flow responsive valve according to an embodiment of the present invention, fitted for controlled fluid flow restriction; and

Figs. 8A to **8F** are longitudinal sections through the valve of Fig. 7, at consecutive operative positions.

DETAILED DESCRIPTION OF THE INVENTION

The present invention is suitable for implementation in a variety of fluid supply systems, however, for the sake of convenience and for exemplifying only, reference hereinafter is made to a water supply system, e.g. an urban/municipal water supply network.

Attention is first directed to Fig. 1 of the drawings schematically illustrating an end portion of an urban/municipal water supply system wherein an end user is for example a house, an office, a plant, etc. The house, in the present example, is connected to a main water supply line designated **10** via a flow meter **12** with a suitable network of pipes **18** branching for example to end devices such as a solar water heating system **20**, wash basins **22**, toilets **26** and garden faucets **28**.

Each of the above end items, including the piping **18** is vulnerable to leaks owing to faulty sealing means (washers, gaskets, etc.), leaks in the piping, poor connections, etc.

In a water supply system not fitted with a device in accordance with the present invention, any such leaks which are below the minimal measurable flow threshold (a common such minimal threshold is about 10 liter/hour) would not be detected and would not be measurable, i.e. causing the water supplier considerable loss, not to mention the waste of fresh water which in some regions in the world is an acute problem.

In order to render a standard flow meter **12** capable of measuring also small amounts of water, there is installed a flow responsive valve generally designated **36**. The valve **36** is sensitive to flow rate and pressure differential over its inlet and outlet ports, as will be explained hereinafter in more detail

The valve **36** is a normally closed valve which opens whenever an end device is opened for consumption of water, e.g. upon flushing the toilet **26** or the like, when the consumed rate exceeds the minimal measurable flow threshold. However, when there is no consumption of water by either of the end devices, the valve **36** spontaneously returns to its closed position. If a leak occurs at one or more locations along the piping **18** or at one or more of the end devices **20, 22, 26** and **28**, the flow responsive valve **36** remains closed whereby a pressure differential ΔP is being built between an inlet **40** connected upstream and an outlet **42** connected downstream. Such a pressure differential is built owing to the essentially constant pressure at the inlet **40** and the dropping pressure at outlet **42**. When the pressure differential ΔP reaches a predetermined threshold, the flow responsive valve **36** opens for a while, to allow water flow to the piping **18** until the valve reaches a pressure differential lower then a predetermined pressure threshold.

Fig. 2 is a superimposed graph schematically illustrating the pressure and flow rate over time, measured downstream of the flow responsive valve **36**. The upper horizontal line represents the minimal measurable flow threshold of the metering device **12** whilst the lower horizontal line represents the flow consumption during a low flow consumption, e.g. owing to several leaks at the piping **18** and/or end devices **20, 24, 26,** and **28** which are below the minimum measurable flow threshold of the metering device **12**. The graph represented by the

letter **Q** represents the pulsating flow character through the flow meter where it is noticeable that flow is always above the minimum measurable flow threshold of the metering device **12** and operates in an on/off mode, i.e. all flow through the meter **12** is measurable. The line represented by the letter **P** illustrates the corresponding pressure in the system which also has a pulsating character.

Further attention will now be directed to several embodiments of a pressure sensitive valve in accordance with embodiments of the present invention by way of examples only. It is appreciated that many other embodiments are possible as well.

Turning now to Figs. 3A and 3B, reference is made to a valve generally designated **50** which in Fig. 3A is illustrated in its open position and in Fig. 3B is illustrated in its normally closed position. The valve **50** comprises a housing **52**, an inlet port **54** and an outlet port **56** both fitted for screw coupling to a pipe section (not shown) by suitable threadings **58** and **60**, respectively.

The valve **50** is fitted with an inlet nozzle **62** having a diameter $\mathbf{D_i}$. A sealing member **64** is axially displaceable within the housing **52** and is normally biased by means of coiled spring **66** into a normally sealed position, so as to seal the inlet nozzle **62** (Fig. 3B).

Sealing member **64** is fitted at an inlet end thereof with a resilient sealing portion **68** for improved sealing of the inlet nozzle **62**. Furthermore, and as noted in the figures, the housing **52** has a central bore **70** slidingly supporting the sealing member **64**, said bore **70** having a diameter $\mathbf{D_b}$. Sealing member **64** has at an outlet end thereof adjacent a shoulder portion **74** having a predetermined tolerance with the bore **70**, said tolerance determining a leak rate corresponding with the pulsating sequence imparted to the sequence, as discussed above.

Further noticeable, bore **70** is formed at an outlet side thereof with an expanded portion **80** of diameter $\mathbf{D_o}$.

The arrangement is such that when the valve **50** is in its open position, the shoulder portion **74** of the sealing member **64** reaches the expanded portion **80** to allow essentially free flow through the valve **50**.

The arrangement is such that the biasing force **Fs** of the spring **66** is predetermined whereby the valve **50** remains in its closed position as long as the pressure differential ΔP does not exceed a predetermined pressure determined by the relationship between $\mathbf{D_I}$, **Fs** and the pressure at the inlet port **54** and outlet port **56**. Thus, the force required to open the valve **50** is determined by $\mathbf{Fs<\Delta P*A(D_i)}$, where $\mathbf{A(D_i)}$ is the surface area at the inlet nozzle **62**. Similarly, the valve **50** will close when $\mathbf{\Delta P<Fs/A(D_o)}$, where $\mathbf{A(D_o)}$ is the surface area at the expanded portion **80**. It is also apparent that the pressure differential required for closing the valve **50** is lower than that required for generating a pulse in the system, this being since $\mathbf{D_i<D_o}$.

The arrangement is such that when the pressure differential over the inlet port **54** and outlet port **56** is smaller than a predetermined threshold, the valve **50** remains sealed since the only force acting is the biasing force **Fs** of spring **66**. However, when pressure at the outlet port **56** drops (e.g. upon a leak at the piping of the system or at one of the end devices, as discussed hereinabove) and there the inlet pressure at inlet port **54** remains essentially constant, the pressure differential over the valve **50** increases and the sealing member **64** will displace into its open position as in Fig. 3A.

Furthermore, it is appreciated that the shoulders **74** of the sealing member **64** take the role in retaining the sealing member in the open position under a pressure differential. It is further appreciated that the tolerance between the diameter of the shoulder **74** and the bore **70** in fact determines the pulsating timing, as it determines a so-called leak rate of the system.

Further attention is now directed to Figs. 4A and 4B in which a valve **80** is principally similar to the valve discussed hereinabove in connection with Figs. 3A and 3B and accordingly, reference is made only to the differing element which is the shape of the shoulder **84** of the sealing member **86** and the corresponding change in shape of the expanded portion **88** of the cylindric bore **90** of the housing. The purpose of this particular design is to give rise to a narrow flow path **91** when the valve is in its open position as in Fig. 4, to thereby give rise to an increased flow

velocity and at the bore **90**, generating a force acting in the direction of arrow **92** (Fig. 4A) namely in the direction to assist in displacing the sealing member **86** into an open position, contrary to the force imparted by coiled spring **94**. This is obtained by local increase of flow velocity causing low static pressure down stream, thus decreasing the head loss.

The design of Figs. 4A and 4B renders the valve **80** open/closed position more significant and avoids undefined positions and scattering of the valve at near to equilibrium position.

Figs. 5A and 5B illustrate still another embodiment of a pressure sensitive valve in accordance with the present invention generally designated **100** wherein the sealing force is imparted by magnetic means, rather than by a coiled spring as in the previous embodiment.

As can be seen in Figs. 5A and 5B, the housing comprises an inlet segment **104** formed with an inlet port **106**, and an outlet segment **108** fitted with an outlet port **110**, both said inlet and said outlet being fitted with a suitable threading for coupling to a pipe segment (not shown).

Outlet segment **108** is formed adjacent the inlet segment **104** with a tapering portion **114** and with a stopper member **116**. A sealing member **120** being a magnetic sphere **122** coated with a resilient layer **124**, has a diameter larger than the narrow most portion of the tapering wall **114** and similarly, the diameter of the sealing member **120** is larger than the gaps **130** of stopper member **116**. The arrangement is such that the sealing member **120** is displaceable within the housing between a closed position (Fig. 5A) wherein it sealingly engages the tapering wall portion **114**, and an open position (Fig. 5A) wherein it disengages from the tapering portion **114** to allow free flow through the valve **100**.

The biasing force is imparted on the sealing member **120** by means of the magnetic inlet member **104** acting on the magnetic sphere **122** of sealing member **120** into sealing engagement with the narrow most portion of the tapering wall portion **114**.

The valve in accordance with the embodiment of Figs. 5A and 5B operates in a similar manner as discussed in connection with the valves of Figs. 3 and 4 and the reader's attention is directed thereto.

A further advantage of the valve in accordance with the present invention, is that it serves also as a one way valve preventing flow from a downstream direction (i.e. from the consumer) to an upstream direction (i.e. towards the supplier). This feature is of particular importance e.g. in connection with a water supply system and serves to prevent flow of contaminated water towards the supplier in case of a flood or burst in supply pipes, where there is risk of mud and dirt entering the system and flowing upstream and possibly contaminating water reservoirs and harming equipment of the water supplier.

Turning now to Fig. 6, there is illustrated a schematic graph representing various situations of measured flow consumption MC versus actual flow consumption AC, in volumetric units, e.g. m3. The line marked I represents the ideal situation where actual water consumption is essentially identical to measured water consumption in a linear fashion. However, this situation will usually not occur owing to the design of common flow meters, e.g. domestic water meters etc., whereby an impeller is provided, the latter gaining inertial forces subject to velocity of water flowing therethrough. Accordingly, even after termination of liquid flow through the flow meter, the impeller will tend to continue revolving for a while, owing to said inertial forces. It is appreciated that this situation is not desired in particular where monitoring of liquid flow is of importance or where it is desired to correctly charge for actual water consumption.

The measured consumption MC for a typical flow meter not fitted with a device in accordance with the present invention is represented by line II and it is thus appreciated that there is a significant portion of unmeasured liquid which cannot be measured and respectively charged.

Upon installation of a valve in accordance with some embodiments, the flow meter will yield an 'over efficient' performance illustrated in Fig. 6 by the line marked III, i.e. measuring quantities of water which in fact were not consumed.

This phenomena takes place owing to many occurrences of closing and opening the valve, involving inertia forces.

Accordingly, it is desirable to introduce a device which will compensate for the 'over efficiency' and will reach a measured consumption near to actual consumption as illustrated for example by line marked IV.

It is appreciated that for good orders sake the performance of the valve in accordance with the line marked IV extends below the optimal line marked I, so as to ensure that the consumer remains under charged rather than over charged.

With further attention now directed to Fig. 7, there is illustrated a modification of the valve in accordance with the present invention, generally designated 150 comprising a housing 152, an inlet port 154 screw coupled to an upstream pipe section 155, and an outlet port 156 screw coupled to a downstream type section 157.

Fitted at the inlet and of the housing there is provided a diaphragm seal 160 retained between an annular shoulder portion 162 of the housing and a diaphragm support disk 164 retained by a retention nut 166, whereby the diaphragm seal 160 is deformable only in a downstream direction, as will be apparent hereinafter, in connection with Fig 8C.

Diaphragm seal 160 tends to follow displacement of the plunger 170 owing to pressure differential about its faces. However, at a certain stage the diaphragm seal disengages from the plunger and will return to its normal position at rest.

A pressure responsive sealing assembly is received within the housing 152, comprising an axially displaceable plunger 170 and a stationary cup member 172.

Formed between the plunger 170 and the cup member 172 there is a dampening assembly received within a confined space 174, which in the present example holds a coiled spring 176 received within the cylindrical sleeve 178 of the cup member 172, said spring biasing at one end against the cup member 172 and at an opposed end thereof against the plunger 170. A sealing sleeve 180, made of a resilient material, is applied over the cylindrical extension 184 of the plunger 170

and 178 of the cup member 172, to thereby restrict liquid flow into the confined space 174.

The circumferential peripheral edge 190 of the plunger 170 is sharp-edged serving as a scraper bearing against the cylindrical surface 194 of the housing, continuously cleaning it from scale, algae and other dirt particles, as the plunger 170 axially displaces within the housing.

According to a particular embodiment, as illustrated in Fig. 7, the plunger 170 and the cup member 172 have complementary shapes offering an advantage in particular in the completely open position of Fig. 8F, upon water consumption downstream. Furthermore, it is noted that the circumferential peripheral edge 198 of the cup member 172 is chamfered so as to easily engage with the corresponding scraper edge 190 of the plunger 170.

Further attention is now directed to Figs. 8A to 8F, illustrating how the valve in accordance with the embodiment of Fig. 7 actually operates. In Fig. 8A, plunger 170 is in its retracted position, remote from the cup member 172 and sealingly bearing against the diaphragm seal 160. This position is the so-called closed position wherein there is no water consumption and no water leak. In this situation, water pressure at the inlet port 154 is substantially equal to the pressure at the outlet port 156, i.e., the pressure differential ΔP equals 0 namely, the inlet pressure equals the outlet pressure ($Pi = Po$).

However, at the position illustrated in Fig. 8B, the valve 150 is still at the so-called closed position with no significant water consumption downstream of the valve, however, with some water leak occurring, at a flow rate which is below the measurable threshold of the water metering device (not shown). This results in pressure decrease at the outlet side of the valve 150, building up a pressure differential $\Delta P \geq 0$ over the valve, where Pi is greater than Po. However, the pressure differential is still not significant and will not displace the valve into the open position. For the sake of clarity, high pressure zone is indicated in Figs. 8A-8F by dense dotting whereas low pressure zone at the valve is indicated by non-densed dotting.It is apparent that in the situation of Fig. 8B the valve remains in the closed

and sealed position wherein the diaphragm seal 170 sealingly bears against the diaphragm seal 160.

Resulting in further leakage, downstream of the valve 150 (however with no significant consumption) the pressure differential over the device 150 increases, causing the plunger 170 to slightly extract in a downstream direction, however followed by deformation of the diaphragm seal 160 which follows the plunger 170 and ensures that the valve is closed. It is apparent that as long as no water flow occurs between the inlet port towards the outlet port, the water metering device (not shown) does not sense any flow and will not indicate flow as the measuring element (e.g. an impeller) remains still.

As the pressure continues to drop at the outlet port 156, water leaks through an interstice between the plunger 170 and the surface 194 of the housing 152, resulting in slight pressure increase at the outlet port 156, and further resulting in displacement of the diaphragm seal 160 to its normal position as in Fig. 8D.

In order to facilitate leakage between the scraper edge 190 of the plunger 170 and the surface 194, one or more narrow grooves 198 are formed at contact zone of the scraper edge 190 with the surface 194, as illustrated in the enlarged portion of Fig. 8D.

Disengagement of the diaphragm seal 160 from the plunger 170 (Fig. 8D) results in further displacement of the plunger 170 towards the cup member 172, whereby water flow is increased, further resulting in pressure equilibrium about the sealing assembly 168. Such an increase in water flow is above the minimal readable threshold of the metering device (not shown) and thus the water now flowing through the device at such a pulsating opening of the valve, is measurable by the flow meter.

The restricted flow at the position of Fig. 8D ensures that the impeller of the flow metering device does not spin at high speed and thus does not gain high inertial forces and accordingly, when a flow pulse through the valve device 150 ceases, the impeller of the flow meter will immediately halt thus not incurring excessive metering.

In this position, the sealing sleeve 180 facilitates slow filling of water into the confined space 174, thus dampening/slowing the closing stage of the valve, thereby improving the ratio between the measured consumption MC and the actual consumption AC.

It is however appreciated that the position of Fig. 8E is not a water consuming position but rather a position in which the piping downstream is refilled at a measurable pulse of water flow, to compensate for the water which has dripped from the piping and from the different supply devices.

With further reference to Fig. 8F, the valve 150 is illustrated in a completely opened position wherein water is consumed by a consumer downstream (not shown) resulting in complete displacement of the plunger 170 into engagement of the edges 170 with the corresponding edge 198 of the cup member 172, to give rise to an egg-like aerodynamic shape, facilitating water flow in a downstream direction at high flow rate, as per demand.

The addition of a dampening assembly, i.e. the sealing sleeve 180 or any other damping means, e.g. a viscous fluid, friction arrangements, water orifice, etc. will result in measured consumption MC near to line IV in Fig. 6 whilst in the absence of such a damping assembly, the measured consumption is near to line III in Fig 6.

At the absence of sealing sleeve 180, one would possibly sense a short delay in water supply upon consumption downstream, e.g. upon opening a tap, etc., owing to water first entering the confined space 174 and only then flowing through the outlet 156 downstream. However, applying the elastic sealing sleeve 180 ensures that upon rapid build up of differential pressure over the device (as a result of water consumption downstream), above a predetermined threshold, the sealing sleeve 180 will deform to disengage from the cylindrical portion 178 of the cup member 172, thus facilitating rapid draining of the confined space 174, whereby a consumer downstream does not feel a pressure drop.

It is appreciated that the above embodiments are merely example of valves suitable for use with a metering system and method as disclosed above and many

other such valves may be designed, all of which fall within the scope of the invention.

CLAIMS:

1. A fluid metering system comprising a fluid supply line and a fluid meter for measuring fluid flow therethrough, said meter having a minimum measuring flow threshold; the system further comprising a valve having an inlet port and an outlet port; said valve shiftable between an open position at flow rates above its minimum measurable flow threshold, and a pressure pulsating position depending on pressure differential over its ports, said pressure pulsating position altering between a closed position essentially prohibiting fluid flow therethrough at flow rates below the minimum measuring flow threshold, and an open position admitting fluid flow into the supply line at a measurable flow rate above the minimum measuring flow threshold.

2. The fluid metering system according to Claim 1, wherein the valve is a normally closed pressure controlled valve.

3. The fluid metering system according to Claim 1, wherein the valve is fitted adjacent before or after the fluid meter.

4. The fluid metering system according to Claim 1, wherein the valve is integrated with the fluid meter.

5. The fluid flow metering system according to Claim 1, wherein portions of the supply line and devices fitted thereon, downstream of said pressure controlled valve, act as a fluid accumulator.

6. The fluid metering system according to Claim 1, wherein the system is a liquid supply network.

7. The fluid metering system according to Claim 6, wherein the system is a municipal water supply network.

8. A fluid metering system comprising a meter for measuring fluid flow and having a minimum measuring flow threshold; the system further comprising a flow responsive valve having an open position admitting fluid flow only at a flow rate above the minimum measuring flow threshold, and a closed position substantially restricting fluid flow at flow rates below the measuring threshold.

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9. A fluid metering system comprising a fluid supply line and a meter for measuring fluid flow therethrough, said meter having a minimum measuring flow threshold; the system further comprising a flow responsive valve imparting the system with a flow pattern having a pulsating character so as to substantially prohibit flow at a flow rate below the minimum measuring threshold, and resume flow of only measurable quantities of fluid.

10. The fluid metering system according to Claim 9, wherein the flow responsive valve is shiftable between an open position whenever pressure differential over an inlet port and an outlet port thereof exceeds a minimum pressure threshold, to thereby admit fluid flow at a flow rate above the minimum measuring flow threshold, and a closed position substantially prohibiting fluid flow therethrough.

11. The method according to claim 1, wherein the valve is a one way valve, preventing flow in an upstream direction.

12. A method for metering fluid flow through a fluid supply line comprising a flow meter having a minimum measurable threshold and a flow responsive valve imparting a flow pattern therethrough with a pulsating character so as to substantially restrict flow at a flow rate below the minimum measuring threshold, and resume flow of only measurable quantities of fluid.

13. The method for metering fluid flow according to Claim 12, wherein average fluid flow through the system remains constant over time, wherein the average fluid flow through the supply line remains constant over time flow rate fluctuations imparted by the system according to the present invention are not acknowledgeable.

14. The method for metering fluid flow according to Claim 12, wherein the flow responsive valve is fitted adjacent to or integrally with the flow meter.

15. The method for metering fluid flow according to Claim 12, wherein portions of the supply line and devices fitted thereon, downstream of said pressure controlled valve, act as a fluid accumulator.

16. A valve comprising an inlet port connectable to an upstream side of a fluid supply line, and an outlet port connectable to an downstream side of the fluid supply line; a control chamber extending between the inlet port and the outlet port and a sealing member disposed within said control chamber; said sealing member having an inlet sealing surface having a sealing surface area and a control portion having a control surface area; and a bleed aperture determining a minimal flow threshold through the control chamber; wherein the sealing member displaces between an open position and a closed position depending on a pressure differential over the sealing member.

17. The valve according to Claim 16, being a normally closed flow responsive valve and wherein the sealing member is biased into sealing engagement of the inlet port.

18. The valve according to Claim 17, wherein the sealing member is spring biased into sealing engagement of the inlet port.

19. The valve according to Claim 17, wherein the sealing member is magnetically biased into sealing engagement of the inlet port.

20. The valve according to Claim 19 wherein the sealing member comprises a ferromagnetic member and a housing of the device is fitted with a fixed magnetic biasing member, to thereby bias the sealing member into sealing engagement of the inlet port.

21. The valve according to Claim 20, wherein the sealing member is coated with a resilient material.

22. The valve according to Claim 16, for imparting a fluid supply line with a pulsating fluid flow pattern, extending between a sealed position and an open position, and wherein the average fluid flow through the supply line remains constant over time flow rate fluctuations imparted by the system according to the present invention are not acknowledgeable.

23. The valve according to Claim 16, wherein the sealing surface area is smaller than the control surface area.

24. The valve according to Claim 16, wherein the bleed aperture is an interstice between a housing of the device and the control portion.

25. The valve according to Claim 17, wherein a flow restriction is formed at the open position, so as to increase flow speed at a downstream side of the sealing member, to thereby give rise to a force in a direction opposed to a sealing force acting on the sealing member.

26. The valve according to claim 24, wherein the surface area is a cylindrical bore of the housing of the valve; the bore is formed with an expansion and the sealing member is formed with a tapering portion corresponding with the expansion, thereby giving rise to head loss when the sealing member displaces into an open position, so as to increase opening force of valve.

27. The valve according to claim 16 being a one way valve, preventing flow in an upstream direction.

28. A flow responsive valve for a flow metering system comprising a fluid meter having a minimum measuring flow threshold; said valve being shiftable between an open position at flow rates above the minimum measuring flow threshold, and a pressure pulsating position depending on pressure differential over its ports, said pressure pulsating position altering between a closed position essentially prohibiting fluid flow therethrough at flow rates below the minimum measuring flow threshold, and an open position admitting fluid flow into the supply line at a measurable flow rate above the minimum measuring flow threshold.

29. A flow responsive valve for a flow metering system comprising a fluid meter having a minimum measuring flow threshold; said valve being shiftable between an open position at flow rates above the minimum measuring flow threshold, and a pressure pulsating position depending on pressure differential over an inlet port and an outlet port of the valve; said pressure pulsating position altering between a closed position essentially prohibiting fluid flow therethrough at flow rates below the minimum measuring flow threshold, and an open position admitting fluid flow into the supply line at a measurable flow rate above the minimum

measuring flow threshold; said valve further comprising a suspension mechanism for delaying fluid flow through the valve at the open state of the pulsating position.

30. A valve according to claim 29, wherein the suspension mechanism comprises a pressure responsive sealing assembly comprising an axially displaceable plunger and a stationary cup member with a damping assembly received therebetween to dampen axial displacement of the plunger.

31. A valve according to claim 30, wherein the damping assembly is received within a confined space with a sealing sleeve applied for restricting liquid flow into the confined space.

32. A valve according to claim 30, wherein the pressure responsive sealing assembly further comprises a diaphragm seal retained within the housing and being deformable only in a downstream direction.

33. A valve according to claim 30, wherein a circumferential peripheral edge of the plunger is pointed and is adapted to displace against a cylindrical surface of the housing to thereby scrape it from dirt.

34. A valve according to claim 30, wherein facing edges of the plunger and the cup member have complimentary mating shapes.

35. A valve according to claim 31, wherein the damping assembly is a biasing spring bearing At one end against the cup member and at an opposed end against the plunger.

36. A valve according to claim 32, wherein at a closed position thereof the plunger is retracted from the cup member and sealingly bears against the diaphragm seal, where liquid does not flow through the valve, and where the inlet pressure $\mathbf{P_i}$ is equal to the outlet pressure $\mathbf{P_o}$.

37. A valve according to claim 32, wherein upon pressure differential built-up over the valve, the plunger extracts downstream, followed by deformation of the diaphragm seal, to thereby close the valve.

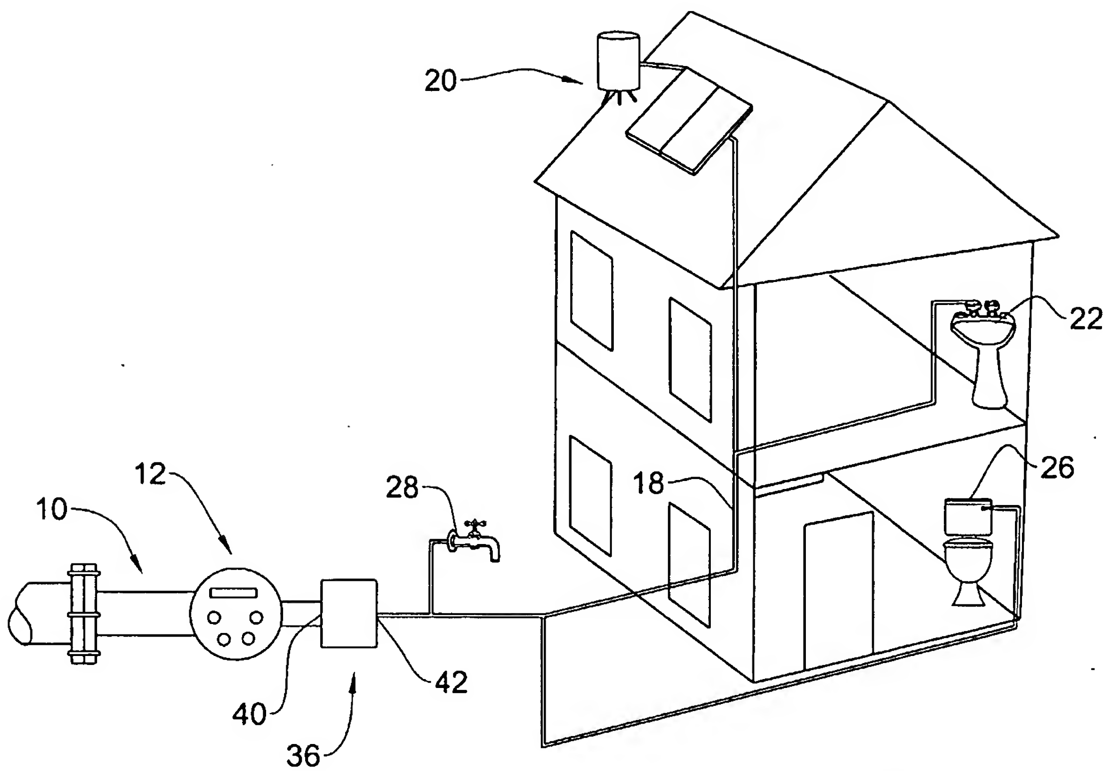
38. A valve according to claim 32, wherein disengagement of the diaphragm seal from the plunger results in further displacement of the plunger towards the cup

member, to thereby increase liquid flow through the valve, at a pulsating regime and at a measurable flow rate.

39. A valve according to claim 32, wherein at an open position of the valve the plunger displaces into engagement with the cup member facilitating liquid flow at considerable flow rate.

40. A valve according to claim 40, wherein at the fully open position of the valve the plunger mates with the cup member to form an egg-like shape.

41. A fluid metering system comprising a fluid supply line and a meter for measuring fluid flow therethrough, said meter comprising a fluid flow responsive impeller and having a minimum measuring flow threshold; the system further comprising a flow responsive valve imparting the system with a flow pattern having a pulsating character so as to substantially prohibit flow at a flow rate below the minimum measuring threshold, and resume flow of only measurable quantities of fluid; said valve further comprising a suspension mechanism for delaying fluid flow through the valve at the open state of the pulsating position.


20
22
26
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18
12
10
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36
42

FIG. 1

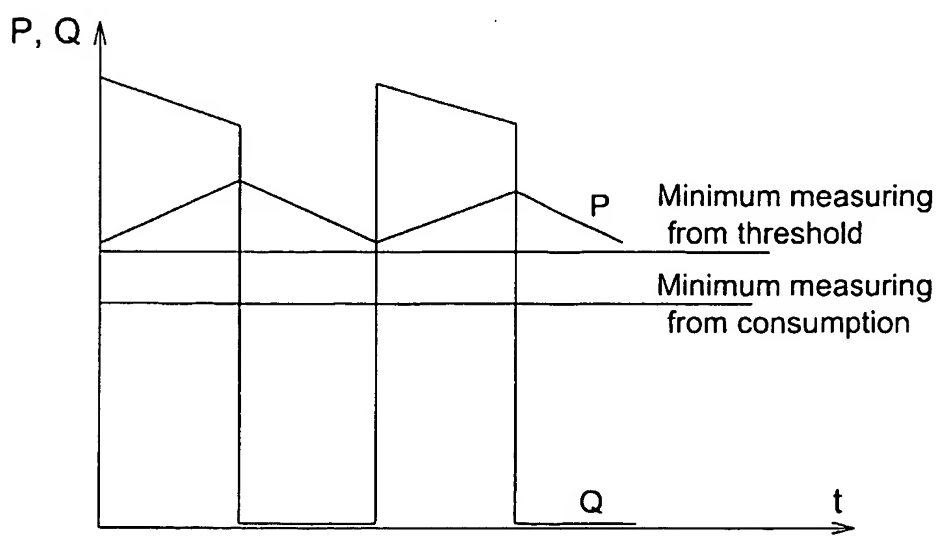
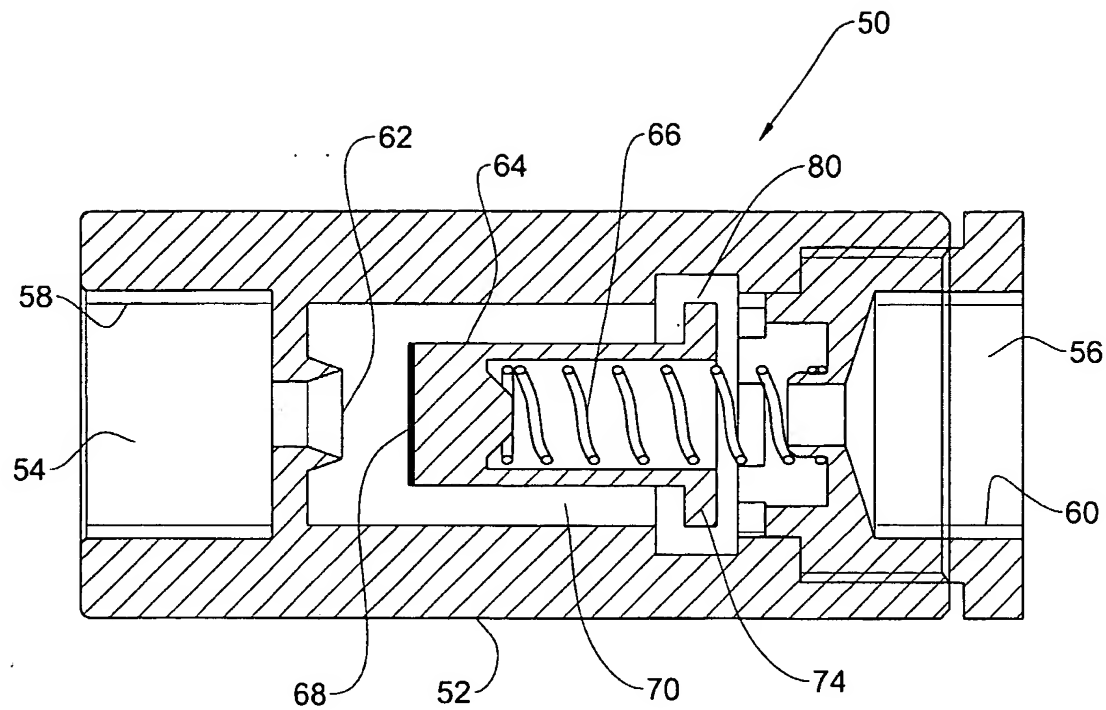

P, Q
P
Minimum measuring
from threshold
Minimum measuring
from consumption
Q
t

FIG. 2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64
66
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58
56
54
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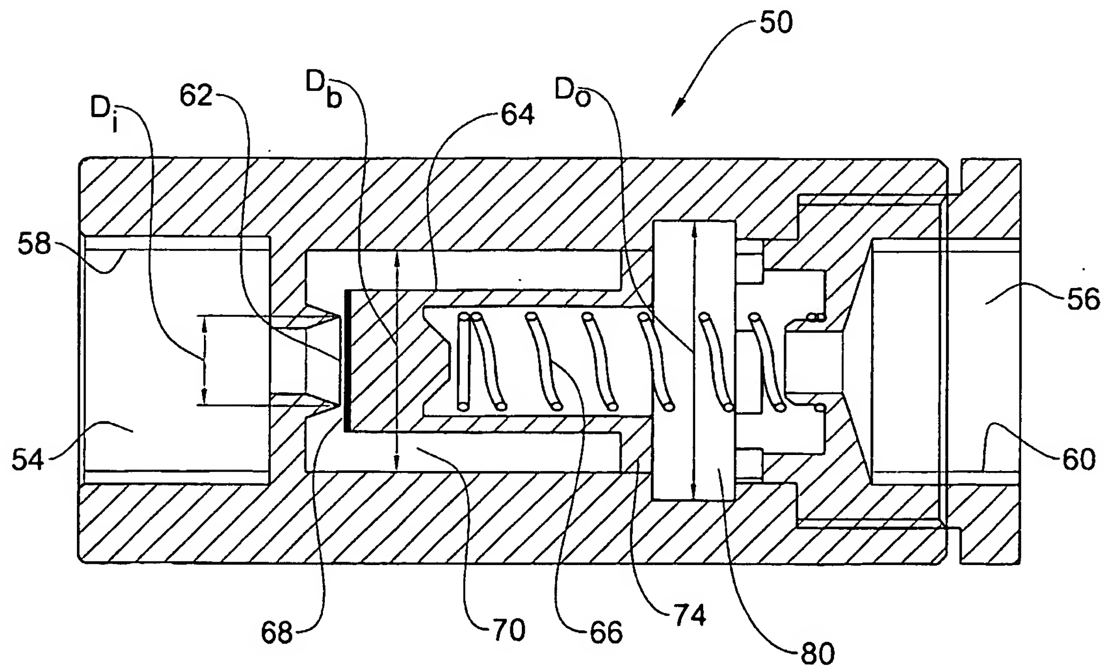
68
52
70
74

FIG. 3A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D
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62
D
b
64
D
o
58
56
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66
74
80

FIG. 3B .

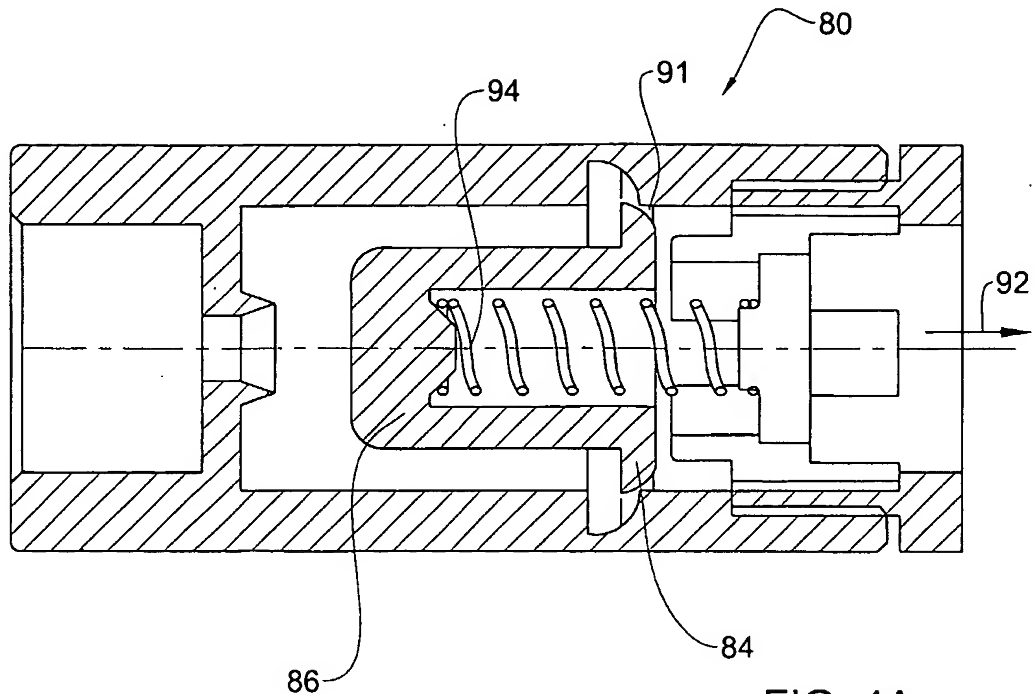


FIG. 4A

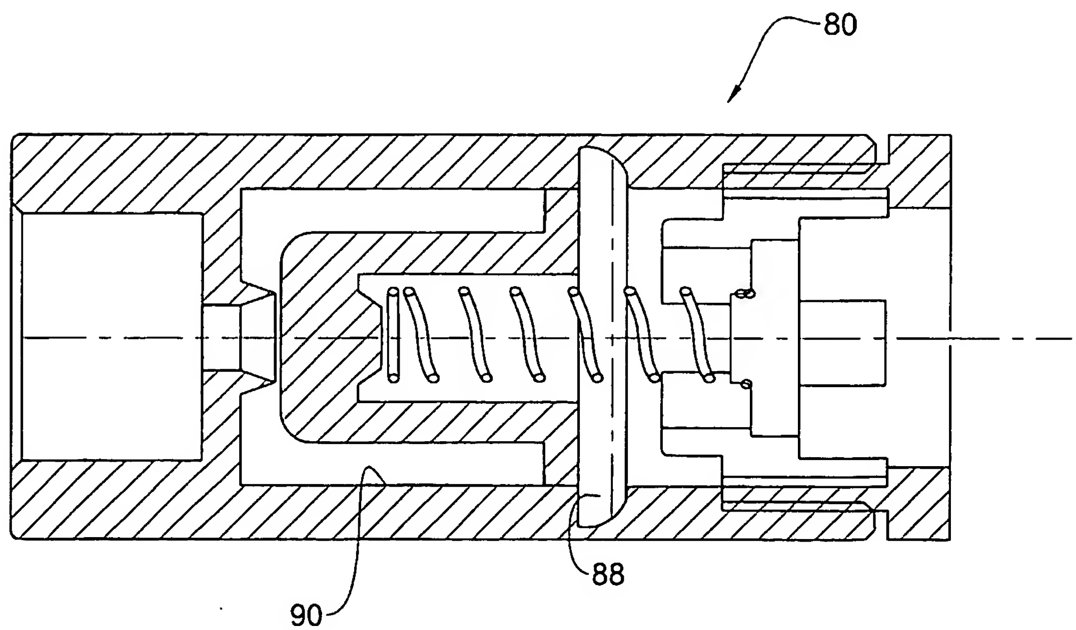
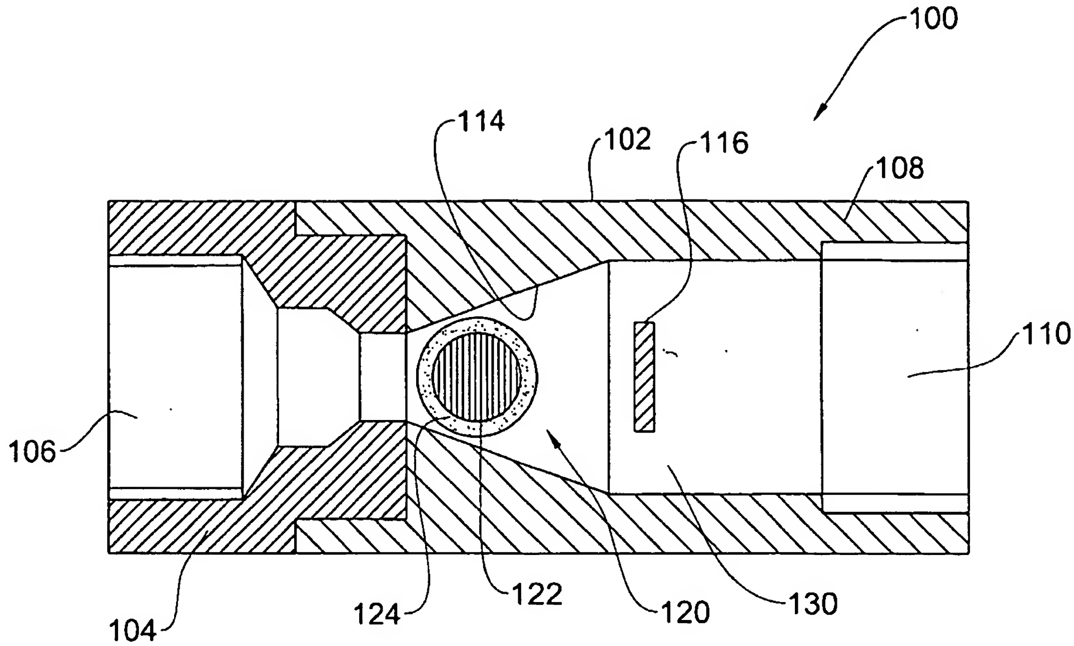


FIG. 4B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114
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116
108
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106
104
124
122
120
130

FIG. 5A

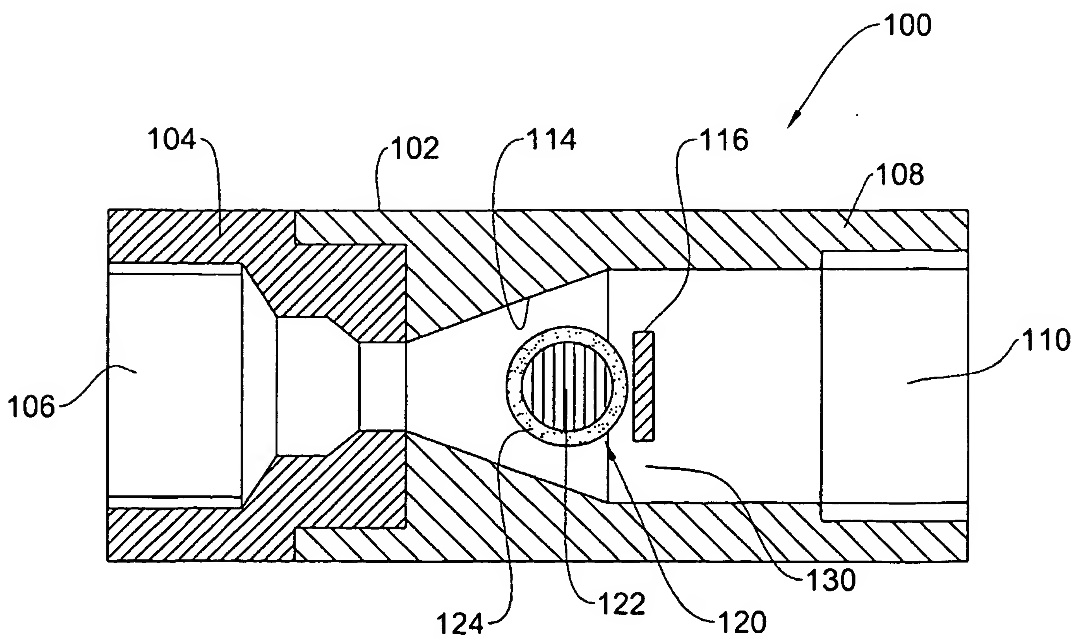
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FIG. 5B

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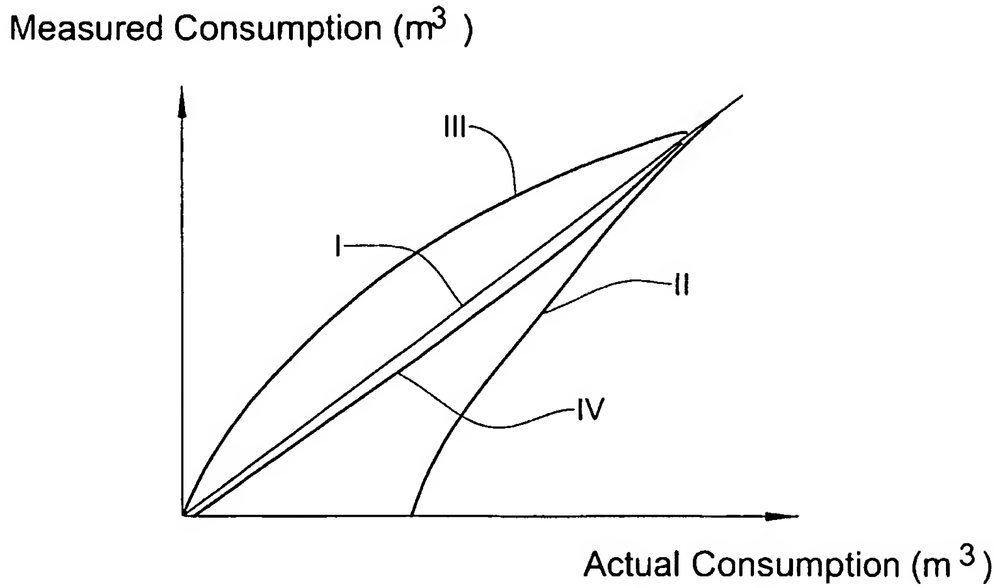

FIG. 6

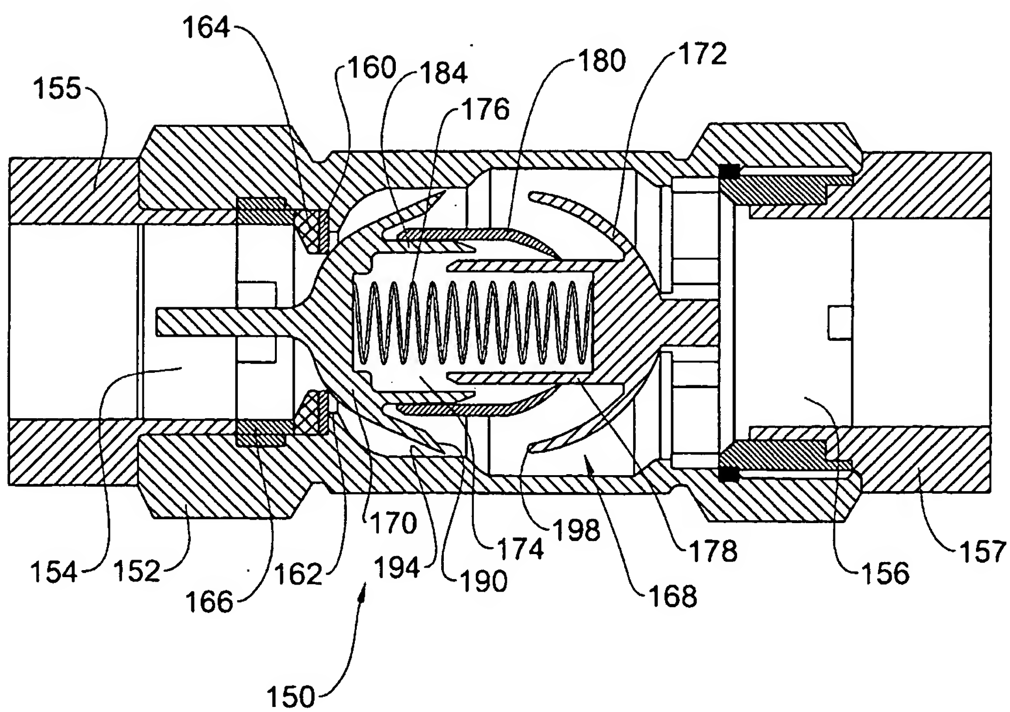

FIG. 7

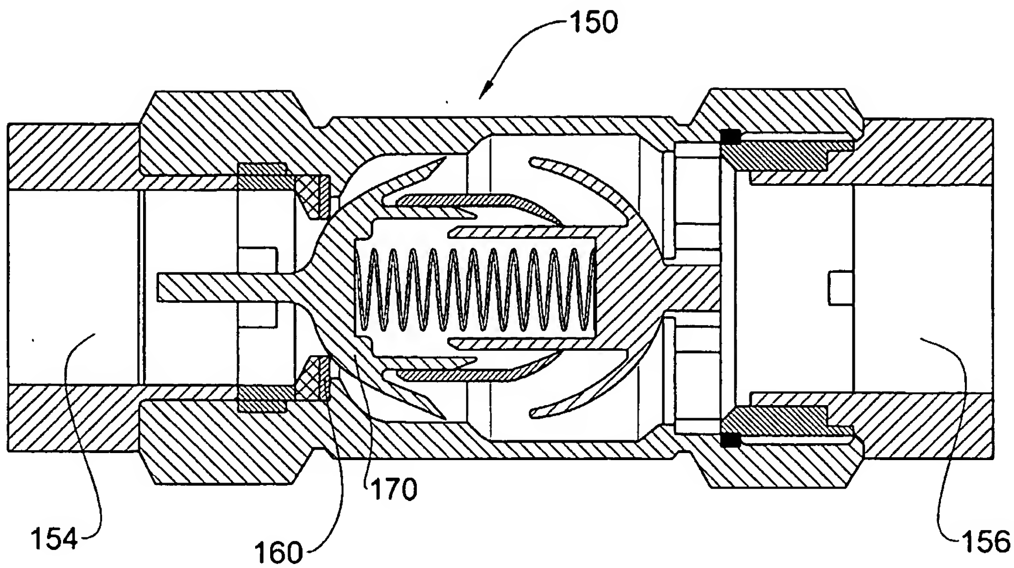

FIG. 8A

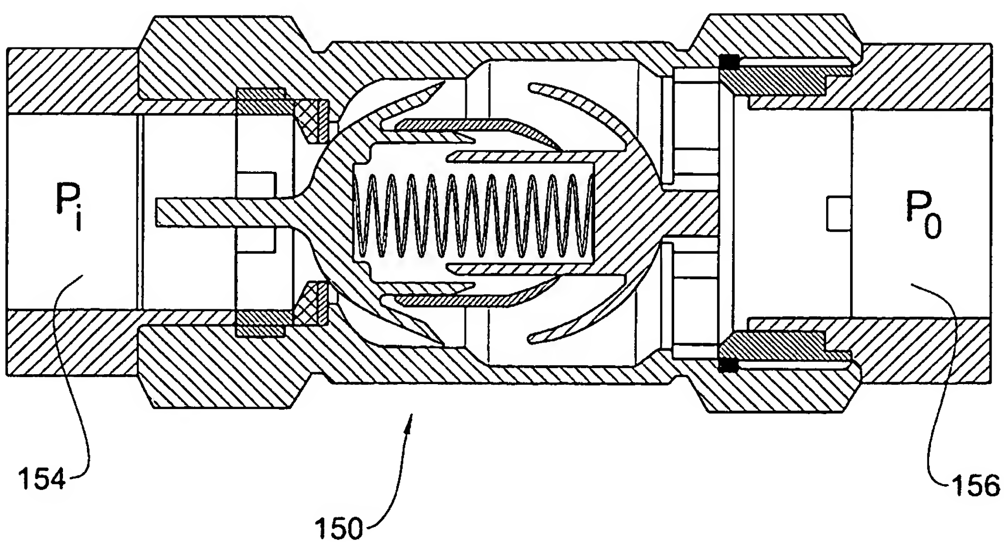

FIG. 8B

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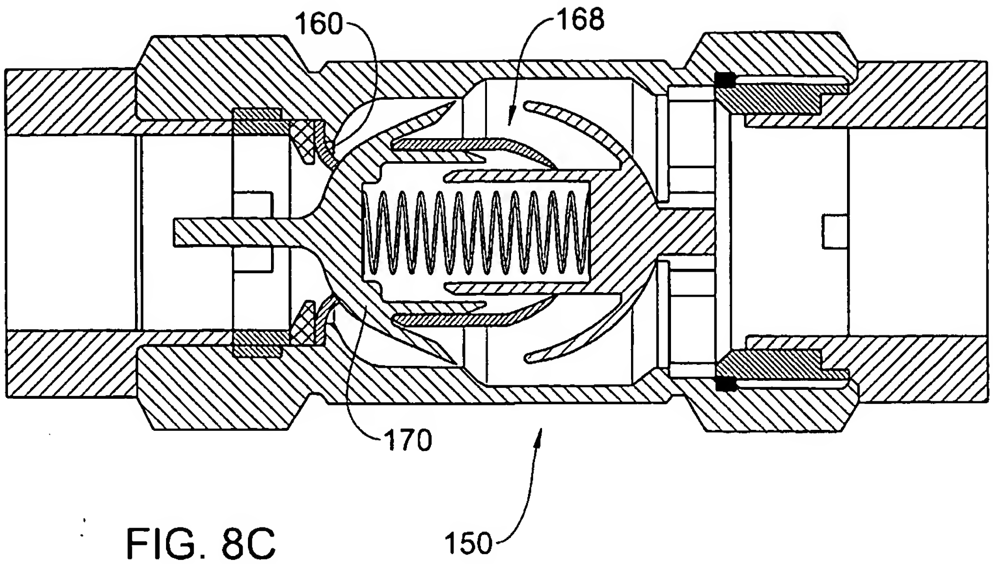

FIG. 8C

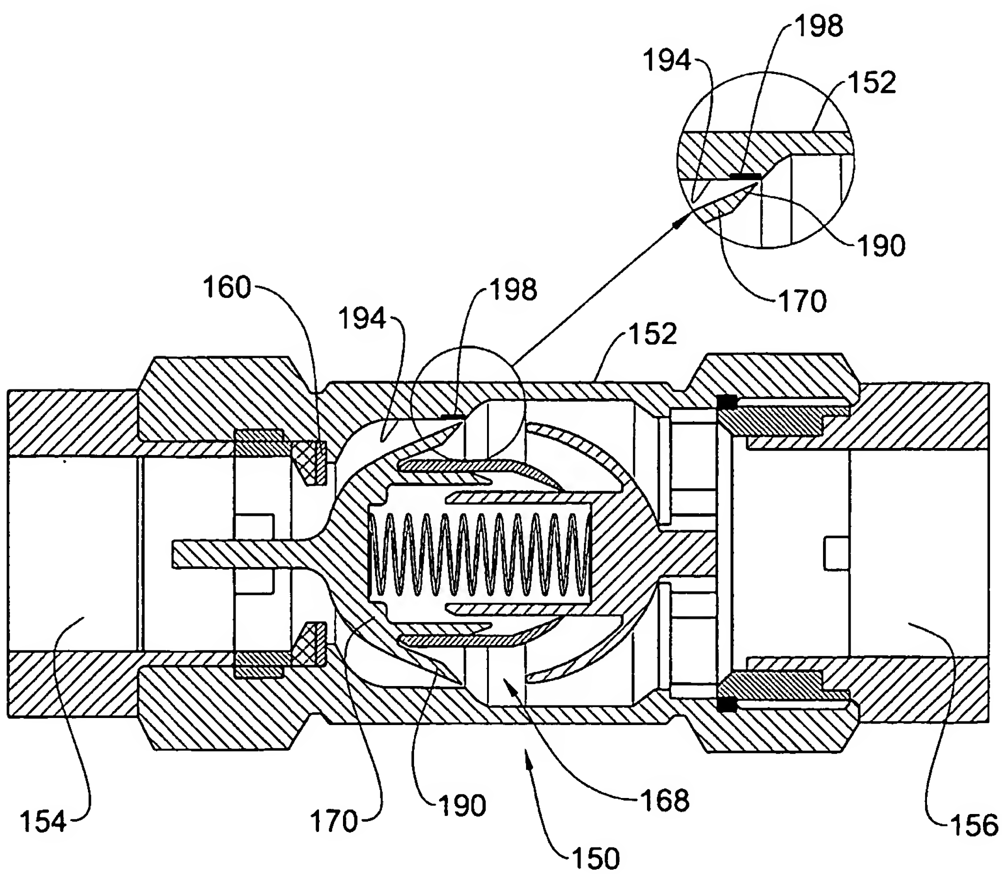

FIG. 8D

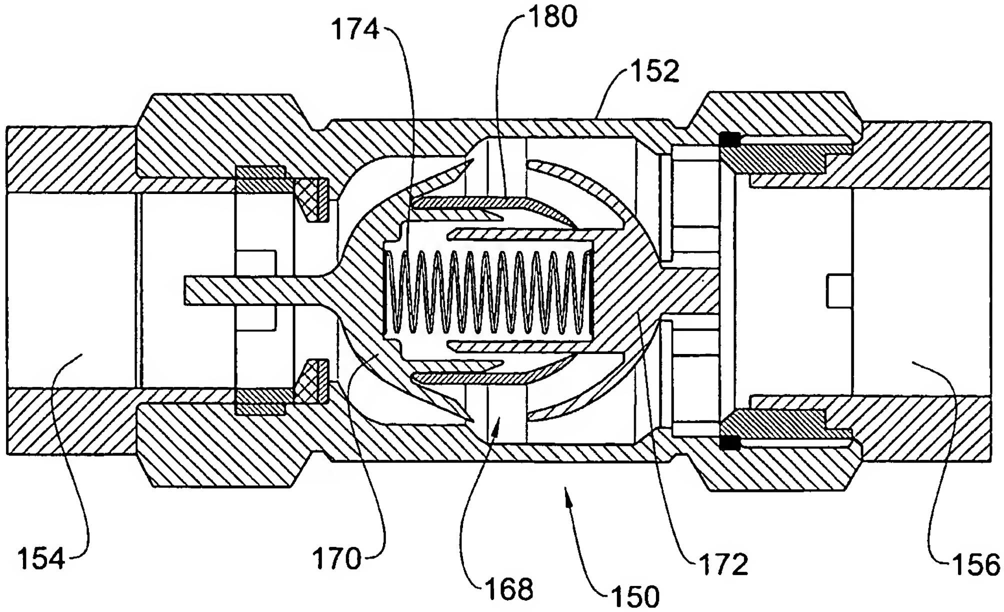
174
180
152
154
170
168
150
172
156

FIG. 8E

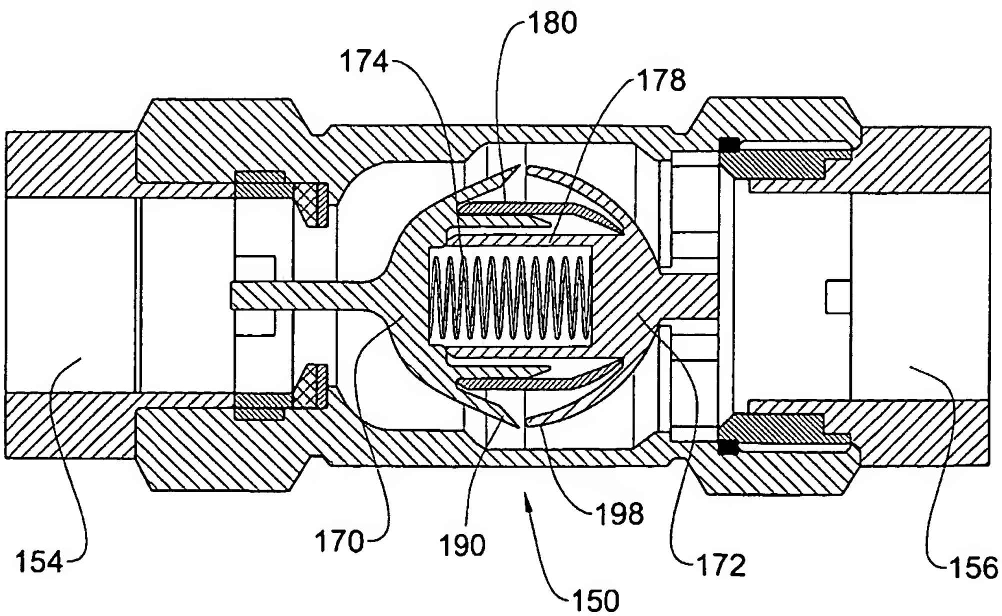
180
174
178
154
170
190
198
150
172
156

FIG. 8F